
Distributed Waste to Energy Conversion: A Piece of the DOD's Renewable Energy Puzzle

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14. ABSTRACT The DoD is the single largest energy consumer in the United States, accounting for over 75% of the U.S. Government's consumption. Providing energy for its extensive physical facility which collectively exceeds 52,000 square miles and 530000 buildings, accounts for approximately 25% of the DoD's annual energy expenditures. Adoption of renewable energy solutions will enable reduction of these costs. Among the myriad of potential energy sources to facilitate the transition from legacy power systems and foreign oil is waste. Municipal solid waste (MSW) is an ever-present burden that, when properly managed, can become a negative cost fuel. MSW generation at DoD installations is estimated to be on the order of 3000 tons per day, thus representing an abundant alternative fuel source. Introduction of waste to energy conversion systems to DoD installations will not only provide for reduction in reliance on traditional energy sources, but will also reduce the environmental impacts of landfill operations. Infoscitex Corporation has developed a modular, containerized waste-to-energy conversion system (the GEM system) that is well-suited to provide distributed power to installations using local waste and biomass. Under ESTCP funding, Infoscitex is demonstrating the technology at a DoD installation. In addition to providing a summary of the GEM system, this talk will summarize the regulatory hurdles encountered during the process of commissioning the unit at a DoD installation in California.					
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DISTRIBUTED WASTE TO ENERGY CONVERSION: A PIECE OF THE DoD'S RENEWABLE ENERGY PUZZLE

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The DoD is the single largest energy consumer in the United States, accounting for over 75% of the U.S. Government's consumption. Providing energy for its extensive physical facility, which collectively exceeds 52,000 square miles and 530,000 buildings, accounts for approximately 25% of the DoD's annual energy expenditures. Adoption of renewable energy solutions will enable reduction of these costs. Among the myriad of potential energy sources to facilitate the transition from legacy power systems and foreign oil is waste. Municipal solid waste (MSW) is an ever-present burden that, when properly managed, can become a negative-cost fuel. MSW generation at DoD installations is estimated to be on the order of 3,000 tons per day, thus representing an abundant alternative fuel source. Introduction of waste to energy conversion systems to DoD installations will not only provide for reduction in reliance on traditional energy sources, but will also reduce the environmental impacts of landfill operations. Infoscitex Corporation has developed a modular, containerized waste-to-energy conversion system (the GEM system) that is well-suited to provide distributed power to installations using local waste and biomass. Under ESTCP funding, Infoscitex is demonstrating the technology at a DoD installation. In addition to providing a summary of the GEM system, this talk will summarize the regulatory hurdles encountered during the process of commissioning the unit at a DoD installation in California.

Acknowledgements



Mood Setters

- Distributed waste to energy conversion can aid the DOD in achieving greater energy security and maintaining US positions
- Waste doesn't grow on trees, radiate from space, or result from air pressure gradients, but it is renewable

Some Context

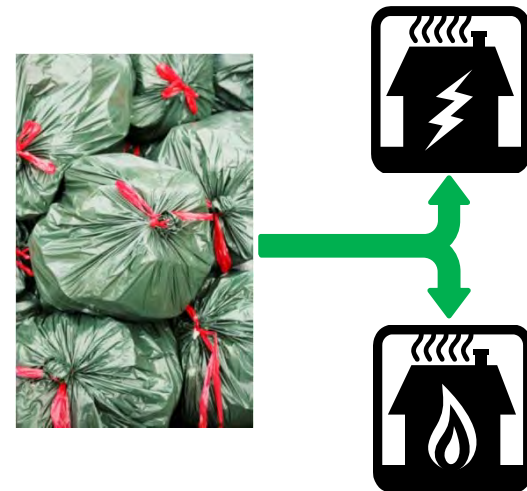
- Security and Economics are driving the need to improve energy efficiency and reduce the cost of power and operations
 - USG consumes about 1.1% of total energy in the US [1]
 - ~200,000 gallons of fuel per day for USMC operations in AFG [2], FOB use is >300 gallons per day [3]
 - In-theatre cost of energy can exceed \$10/kWh [4]
 - Not just forward operations that are feeling the pressure to improve efficiency [5]
- Humans make a lot of trash, and it's predominantly viewed as a burden
 - For example, see first few slides of [6] or visit [7]
- The DOD makes a lot of nice, high energy potential trash
 - ~3000 tpd at installations alone
 - The Army has performed a number of studies characterizing forward waste streams [8,9,10 for example]

References:

- [1] Energy Information Administration, Annual Energy Review, 2006
- [2] MEF-A-REPOL, "Bulk Petroleum Contingency Report," 2010
- [3] GAO Report, "DOD Needs to Increase Attention on Fuel Demand Managements at Forward-Deployed Locations," 2009
- [4] Basis: 38 kWh/gal JP8, \$4.5/gal, Transport mark-up 5-10x, Delivery efficiency 33-50%, Generator efficiency 27%
- [5] Joint DOD/DOE Task Force formed 2008
- [6] Cosper, "Installation Waste Quantity and Characterization," Installation WTE Workshop, 2008 [\[LINK\]](#)
- [7] http://www.nationmaster.com/graph/env_mun_was_gen-environment-municipal-waste-generation
- [8] Rupert et al "Force Provider Solid Waste Characterization Study," Final Report Natick/TR-04/017, 2004 [\[LINK\]](#)
- [9] Canes et al "An Analysis of the Energy Potential of Waste in the Field," Report DRP30T1, 2004
- [10] US Army Corps of Engineers "Solid Waste Generation at Base Camps," 2008 [\[LINK\]](#)

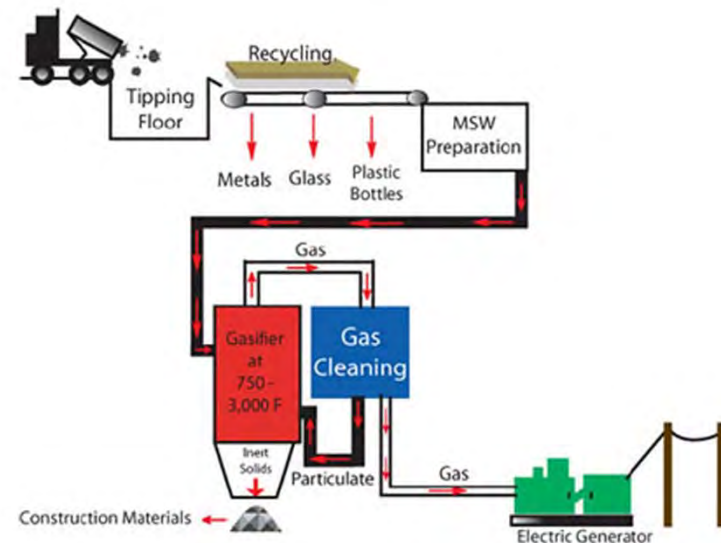
Waste to Energy (WTE) – What're We Talking About?

- WTE = Conversion of waste (i.e. MSW, trash, stuff unworthy of R3, etc) into energy (heat, power, both)
- A number of core technical approaches to WTE
 - Gasification, pyrolysis, biological processes, etc
- Two general scales:
 - Centralized
 - Distributed



Centralized Waste to Energy Conversion

- Municipal-scale plants
- Generate many MWs of Power
- CONOPs:
 - Point of generation collection
 - Tipping at Sorting Facility
 - MSW Segregation
 - Conversion to Producer Gas
 - Centralized Power Generation
 - Distribution of Power to Grid
- PROS:
 - Waste Diverted from Landfill
 - Single Facility to Manage
- CONS:
 - Efficiency
 - Environmental Impact
 - No Value Add for Waste Generators



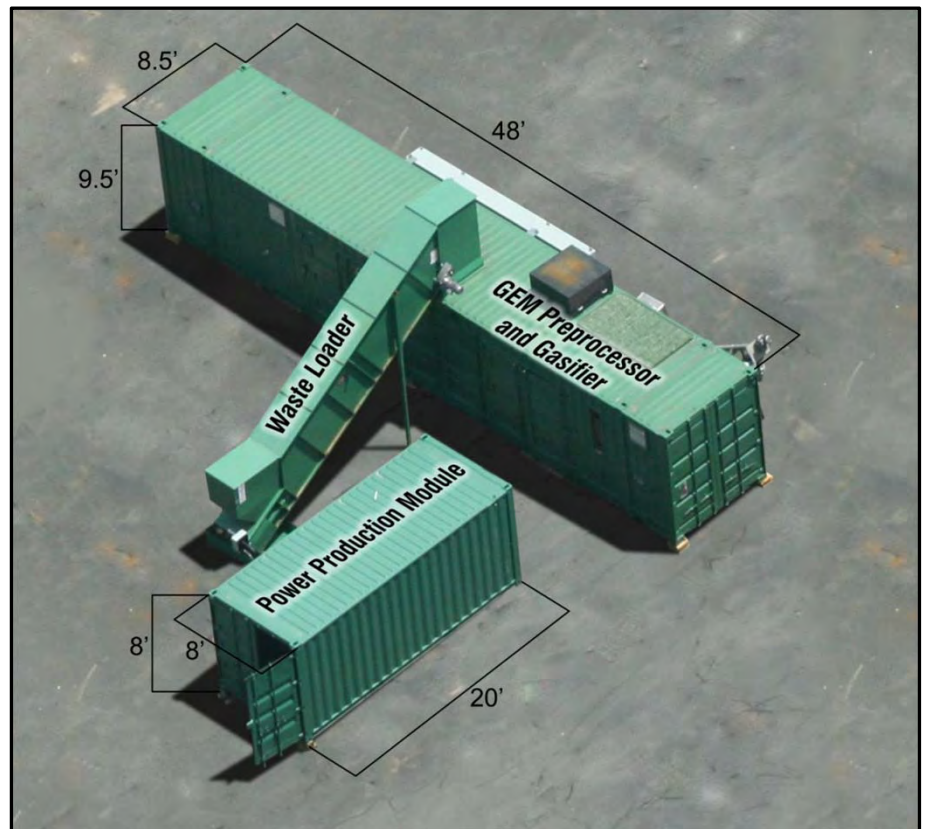
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Distributed Waste to Energy Conversion

- Community/installation-sized systems
- Generate kW's of heat and power
- CONOPs:
 - Waste generated on-site, processed on-site
 - Conversion of MSW to producer gas
 - Power and heat generated and fed to site local grid
- PROS:
 - Waste diverted from landfill
 - Waste generator realizes full value of waste in terms of heat, power, and waste disposal cost avoidance
 - Some solutions offer ability to scale to accommodate changing needs
- CONS:
 - Requires allocation of space to system at the installation
- Few examples, one is the GEM

GEM Distributed WTE System

Modular, containerized system designed to handle mixed solid wastes



GEM Distributed WTE System

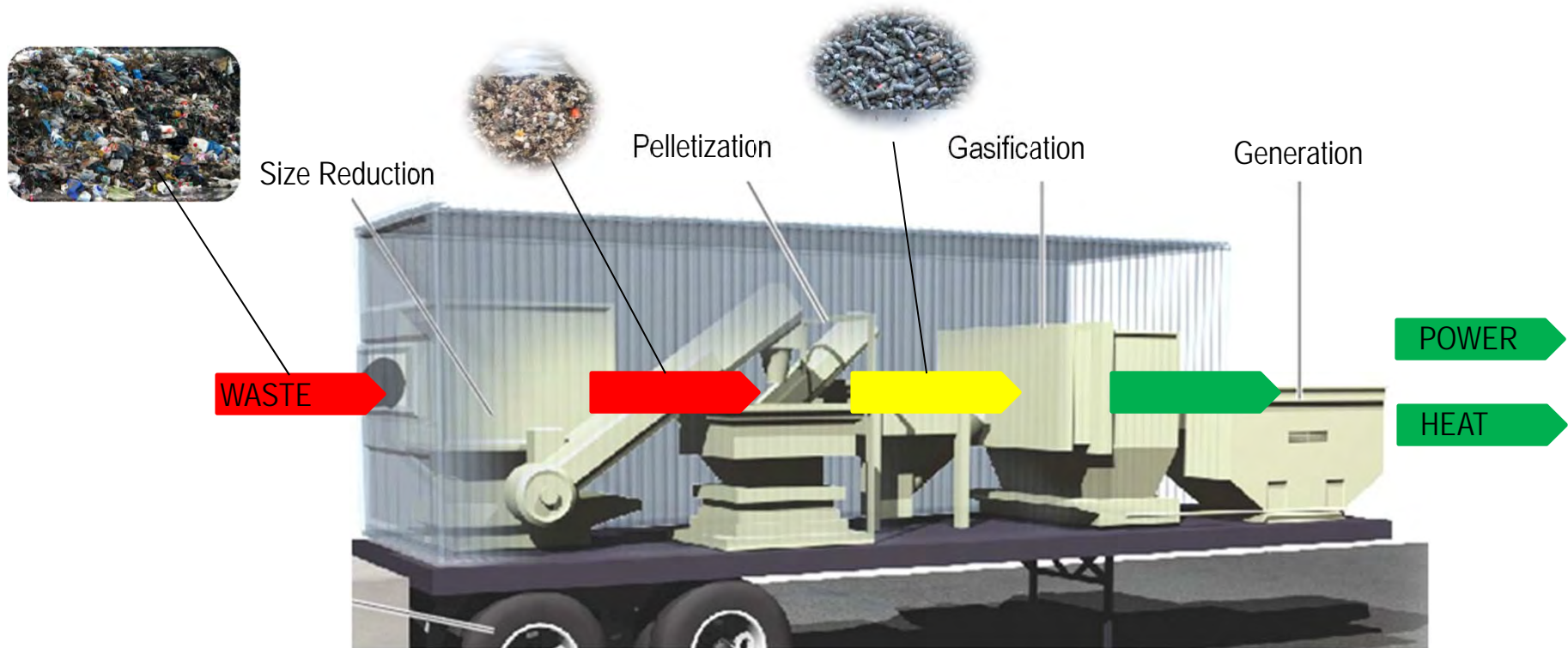
The GEM converts waste into a resource:
600 kWh_e + 1440 kWh_t per ton of waste processed*

Factor	GEM Waste-to-Energy Conversion System
Waste Reduction	~95% by weight reduction in waste (~5% residual ash)
Electricity Output	~75 kW, net
Heat Output	~180 kW, net
Acceptable Inputs	Mixed wastes including paper, plastic, cardboard, food, wood, biomass, etc
Throughput	Three tons per day
Power Requirements	The GEM generates energy and is self-sustaining after start-up
Transportable	The GEM is built into a standard 48' shipping container; and can be built into two containers if preferred
Operator Requirements	No specialized personnel requirement; system designed for autonomous operation with minimal operator input
Availability	Presently in LRIP, capacity to scale production to meet demand in-place; 4-month lead time from order to delivery
Service/Support	IST will provide support for site planning and install; service agreements also available for scheduled maintenance

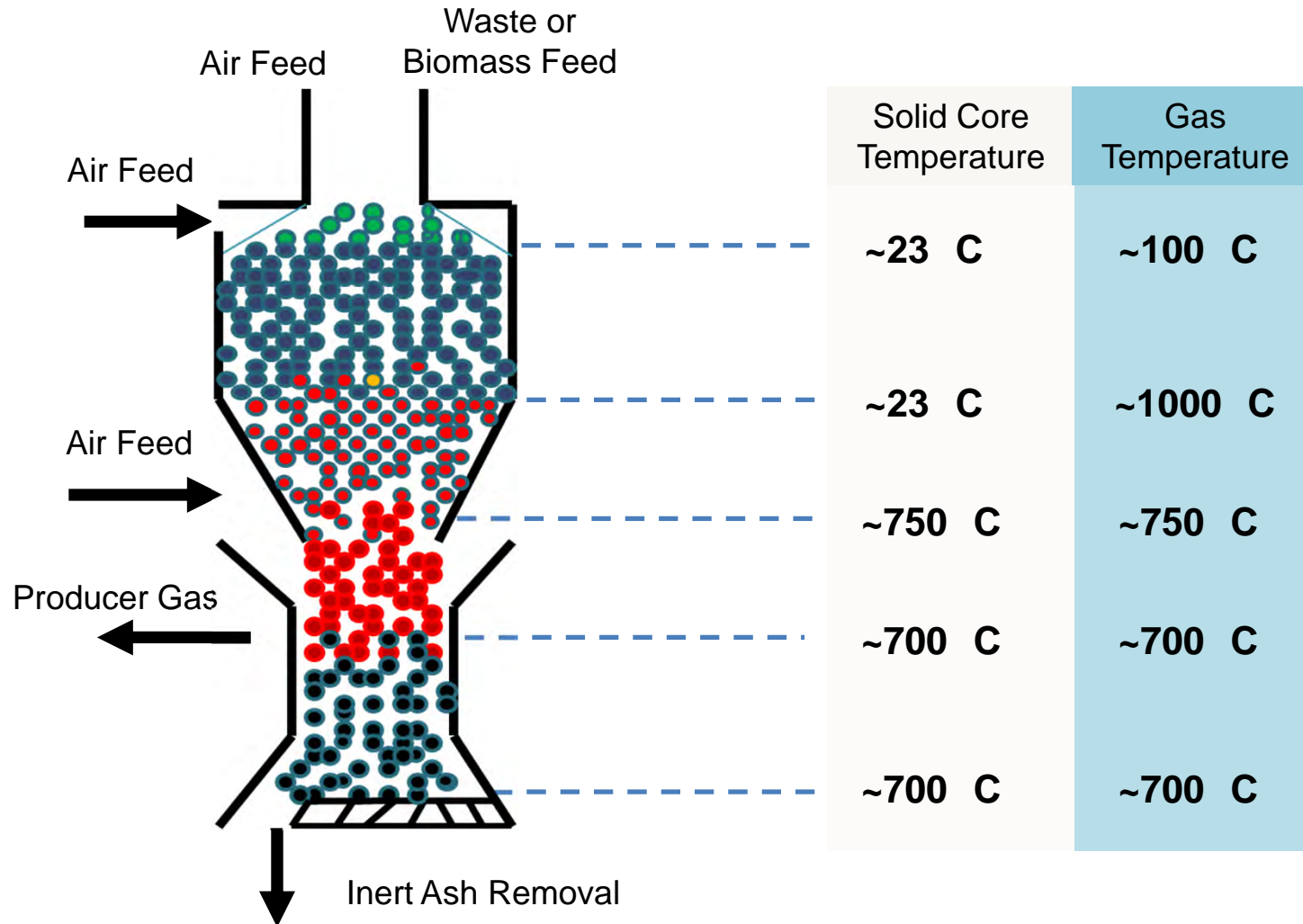
* typical MSW input assumed

GEM: Simplified Process Overview

[Illustrative Description – Not to Scale]



GEM Downdraft Gasification in a Nutshell



Emissions Data

[Modified Diesel Generator Power Plant]

Gas Component	Metric Standard**	GEM
CO	3.7 g/bhp-hr	1.64 g/bhp-hr
SO ₂	30 ppm by dry volume	18 ppm
Aldehydes and Ketones		
Formaldehyde	0.75 ppm	0.0096 ppm
Acetaldehyde	200 ppm	0.0257 ppm
Acetone	100 ppm	0.1247 ppm
Acrolein	.1 ppm	0.0942 ppm
Dioxins and Furans	13 ng/dscm	0.12 ng/dscm

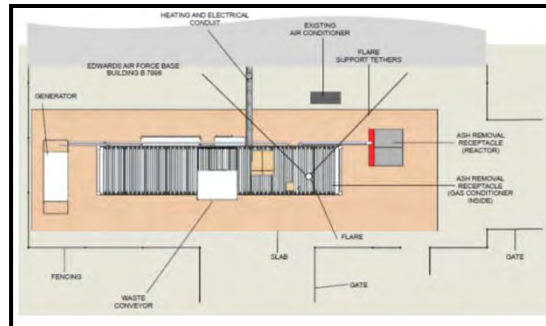
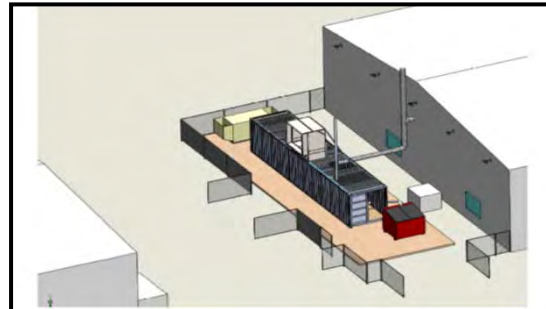
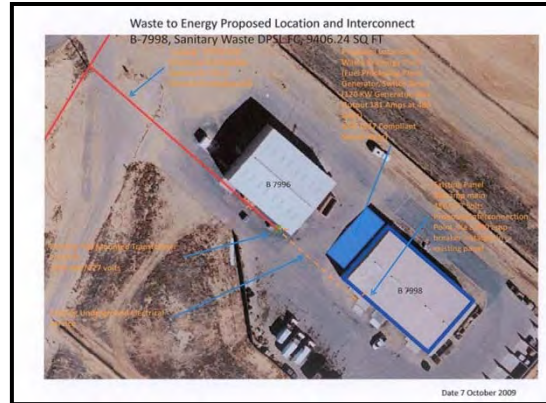
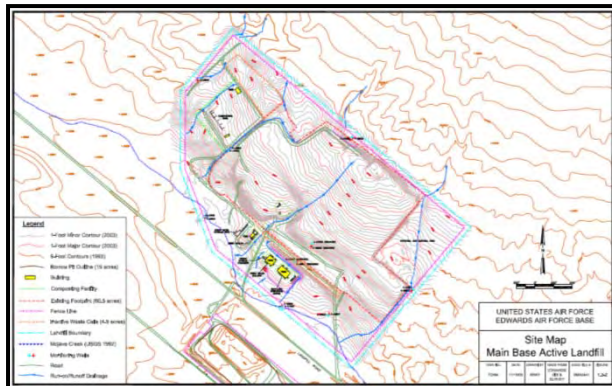
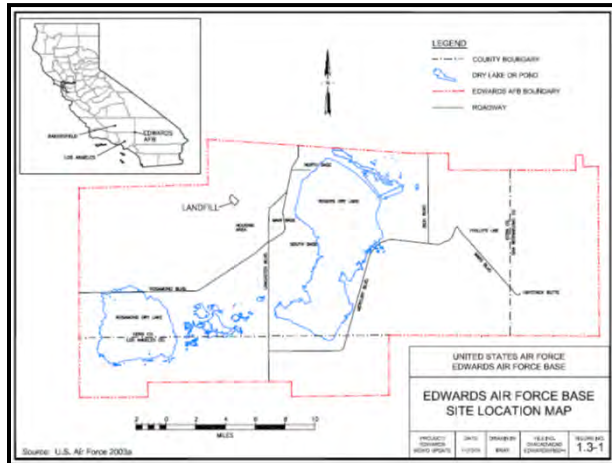
**Standards

- EPA Tier 3 Nonroad Diesel Engine Emission Standard (75 < kW < 130)
- Standards of Performance for Small Municipal Waste Combustion Units

ESTCP Project EW 200932

- Overall Objective:
 - Demonstrate/validate a waste to energy conversion system capable of converting combustible MSW and biomass on fixed installations into electricity and heat
- Performers:
 - Infoscitex, IST Energy, Edwards Air Force Base
- Demonstration Site:
 - Edwards Air Force Base, Landfill Facilities (between buildings 7996 and 7998)
- Performance Objectives:
 - Reduce amount of solid waste requiring landfilling
 - Generate net electricity for on-site use
 - Meet power quality metrics
 - Generate net heat for on-site use
 - Reduce carbon footprint
 - Conform to ambient air quality for State of CA
 - Estimate simple payback
 - Demonstrate system robustness
 - Assess ease of use
 - Demonstrate automated process control
 - Identify single point system failures

EW200932 Dem/Val Scenario



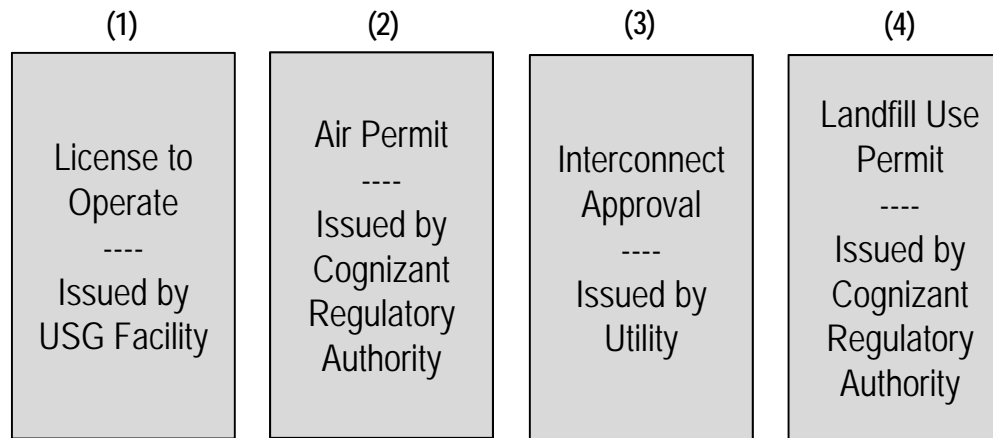
Implementation Process

1. Collect Data
2. Preliminary Econ. Analysis
3. Site Assessment
4. Plan/Proposal Preparation
5. Kick-Off Project
6. Infrastructure Modifications if Required
7. Regulatory Matters
8. Shakedown Unit
9. Install Unit
10. Start-Up Unit
11. Operational

Permitting

- Operation of the demonstration at Edwards AFB requires a number of permits and licenses
- Execution of the “Permitting” task commenced Sep-2009 and is still on-going
 - Ship date is due to be set any day now
 - Last pending regulatory authority approval is expected to be received in Dec-2011
 - Project will operate off-grid at Edwards AFB during period between regulatory approval and interconnect approval, should one exist
- Progress against work plan has been stalled since Nov-2010 due to permitting
 - Significant amount of additional pre-deployment evaluation has been performed
- Fulfillment of the “Permitting” task has involved several iterations:
 - Project onset: We need two approvals –
 - Air Pollution Experimental Exemption [COMPLETE]
 - License to Operate at Edwards AFB [COMPLETE]
 - Iteration 1: We need utility tie-in approval as well –
 - Southern California Edison (SCE) Generating Facility Interconnection Application [PENDING]
 - Iteration 2: We need CA state solid waste authority approval since we’re physically operating at a landfill
 - Legal position letter to State of CA from AF JAG [COMPLETE]
 - Iteration 3: CA State Authority “[we defer to Kern County]”
 - Form CIWMB169 Enforcement Agency Notification submittal to Kern County Environmental Health Services [PENDING]

Permitting



- (1) Ensure host facility is an engaged partner. Edwards AFB is bought in from primary project POC to Base Commander.
- (2) For purposes of dem/val, an experimental exception was obtained.
- (3) Point of major resistance for the project; plan on at least 12 months for this
- (4) Either State or Local authority; for this project, State deferred to County, requiring formal notification of intent to operate activities other than originally approved under master landfill permit

Frequently Encountered – “We like what you’re doing, but we’re just not sure how to categorize it.”

Current Status and 2012 Plans

- Ship unit in December 2011
- Commence demo activities in January 2012
- Conclude demo activities in May 2012
- Publish results in late 2012

Closing Thoughts

- Near-term, evolutionary solutions to energy and environment challenges are realizable
 - Distributed waste to energy conversion is one such example
- Fast-tracking of regulatory changes to account for technological progress is needed for true impact
 - Otherwise, expect a high mortality rate for technologies and companies pushing the envelope

Questions?

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